A Comprehensive Food Access Analysis in Tucson

Making Action Possible in Southern Arizona (MAP Dashboard)
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Executive Summary
Adequate access to healthy food has become a more pressing societal issue due to factors such as the recent recession and continued challenges with un- and under-employment depressing income in many areas. More than 14% of American households (17.5 million) were estimated to be food insecure during 2013 in the latest Economic Research Report by U.S. Department of Agriculture (USDA). "Food desert" refers to geographically isolated locations where access to healthy, affordable foods (especially fruits and vegetables) is limited or non-existent (Mari Gallagher 2006; 2007a; 2007b; Powell et al. 2007). While most food desert studies focus on brand-name chain stores, this project also examines whether independent stores help reduce food deserts, to what extent these stores change food access and in what geographical and social locations such changes take place. In addition to food deserts (a proximity-based food access assessment), this project addresses aspects of food store diversity and variety in a comprehensive evaluation of food access, especially in low-income neighborhoods. Further, inconsistent results introduced by the use of alternative geographic scales are examined. The study is conducted in Tucson, AZ where a high poverty rate (20.4%) has been found. The study has critical policy implications for both government policy-makers and practitioners. The research findings can be used to facilitate governmental and non-governmental agencies' planning of food and nutrition service. The private sector, such as retailers, can also be provided with our analysis to assist them with decisions of where to locate, which may also lead to improved food accessibility and social welfare.

1. Introduction

Adequate access to healthy food has become a more pressing societal issue due to the recent recession and continued challenges with un- and under-employment depressing income combined with food price increases due to, for example, drought in food producing locations (Campbell and Duisin 2014). In recent years, the number of families who are food insecure and in need of food assistance has increased substantially. The largest source of federal food assistance - supplemental nutrition assistance program (SNAP), commonly known as the food stamp program, reported that in 2012 through 2014 the number of food stamp beneficiaries rose to the highest level in history, serving 15% of the total U.S. population (USDA 2015a). Those most at risk for food insecurity are persons living below the poverty level, the elderly, the disabled, women and children (Ziliak and Gundersen 2014). Research reveals that low-income populations in the U.S. have a higher incidence of obesity, diabetes, high blood pressure and other diseases related to food insecurity and access to healthy food (Adams et al. 2003).

The concept of 'food deserts' was developed to define geographically isolated locations where access to healthy, affordable foods (especially fruits and vegetables) is limited or non-existent because of the absence of full-service grocery stores within easy traveling distance (Mari Gallagher 2006; 2007a; 2007b; Powell et al. 2007). Food deserts are in part due to profit-driven food industries that tend to target profitable, high-income populations leaving poor neighborhoods either unserved or underserved. The low food access to healthy foods has been found to "exacerbate disparities in health outcomes" in disadvantaged neighborhoods (Wallop 2013).

In addition to the U.S., there has been a growing attention to food deserts in developed countries including the U.K., Canada, Australia and New Zealand. Factors/criteria used to identify food

deserts vary within regions (e.g. urban vs. rural) and countries (partially due to availability of transportation means). In the case of the U.S., "urban neighborhoods and rural towns without ready access to fresh, healthy, and affordable food" are defined by the USDA as food deserts. The USDA, Treasury Department and HHS (Department of Health and Human Services) all identify food deserts based on the geographic units of census tracts with two criteria being implemented for locating food deserts: low income and low access. More specifically, low access is operationalized using a 1-mile maker (the distance to the closest supermarket) in urban areas and 10-mile marker in rural areas where vehicle ownership is often high. According to the USDA's Economic Research Service (ERS), approximately 23.5 million people in the U.S. live in a food desert[1] (USDA 2015b).

While the use of census tracts for identifying food deserts is practical for government policy makers and practitioners to implement policy decisions, we believe that the scale is too coarse for providing sufficient knowledge about the geographic variation existing in different food deserts across distinct neighborhoods and communities. Our analysis for this MAP project will also examine food desert identification based on block group units (a finer resolution than the census tract units), representing the smallest census units with a range of socioeconomic information available. Also, the cutoff-threshold based method used to differentiate food deserts and non-food deserts are limited in providing a full depiction of food access conditions. For example, according to current food desert designation practices, low income neighborhoods that have their closest supermarket within 0.99 miles are considered non-food deserts compared with those that have their closest supermarket that are 1.01 miles away. We also highlight that having one market within a certain distance only provides a partial story about food access; in this study we also examine the variety and diversity of food stores available within a reasonable travel distance.

Further, the USDA's criteria for selecting grocery stores/supermarkets as healthy, affordable food retailers follow the industry-standardized definition of a supermarket where "a retailer must have annual sales of at least $2 million and contain all the major food departments found in a traditional supermarket, including fresh meat and poultry, produce, dairy, dry and packaged foods, and frozen foods" (USDA 2009). Consequently, most food access studies focus on brand-name chain stores selling a full range of goods at competitive prices. As noted by Apparicio et al. (2007) "other food retailers…and ethnic grocery shops may be present in deprived areas with poor accessibility to a supermarket…the presence of smaller or independent grocery shops could thus fill the gap caused by the absence of supermarkets". A recent study on Southeastern San Diego came to the same conclusion (Joassart-Marcelli et al. 2014). In this study, we also include such independent stores to examine whether these food outlets help reduce food deserts, to what extent these food outlets change food access in general and in what geographical and social locations such changes take place.

[1] The estimate was originally given in the 2009 report "Access to Affordable and Nutritious Food—Measuring and Understanding Food Deserts and Their Consequences: Report to Congress" by USDA's ERS. Also see http://ers.usda.gov/publications/ap-administrative-publication/ap-036.aspx

Our comprehensive food access study is conducted in Tucson, Arizona. The study area is well-suited for the research for the socioeconomic diversity of its residents, uneven spatial distribution of food services and the presence of a diversity of food stores (such as ethnic food stores, Mom-n-Pop stores, and farmer's market). Wide gaps are found in income and educational attainment. Geographic divisions are also prevalent between non-Hispanic whites and Hispanics.

The food accessibility assessments have critical policy implications for both government policy-makers and practitioners. Our research findings can be used to facilitate governmental and non-governmental agencies' planning of food production projects, as well as planning of food and nutrition service to better serve the needs of disadvantaged populations. The private sector, such as retailers, can also be provided with our analysis to assist them with decisions of where to locate, which may also lead to improved food accessibility and social welfare.

2. The Study Area-Tucson, AZ

Poverty and food insecurity in Southern Arizona has been increasing in the past five years. According to a recent U.S. Census Bureau American Community Survey (ACS), the Tucson metro area ranks as the sixth-poorest Metropolitan Statistical Area (MSA) in the nation with an overall poverty rate of 20.4% (Bishaw 2012) and the second poorest among the twelve Western U.S. MSAs (MAP 2015). Connections between poverty, unemployment and food insecurity have been consistently made in the literature (Refer to Gundersen et al. (2011) for a detailed review). A 2009 USDA report revealed that food insecurity rates in Arizona are rising by as much as 4% per year, while 2014 unemployment rates in Arizona is at 6.9% (Weinfield et al. 2014). Feeding America, one of the nation's leading hunger relief charities reported in 2014 that 156,660 people (16% of the total population) in Pima County are estimated to be food insecure (Feeding America Map the Meal Gap 2014). The same report estimates that child food insecurity exists in Pima County at a rate of 25.9%. Furthermore, it is estimated that 30% of all food insecure individuals, and 29% of food insecure children in Pima County are deemed ineligible for Federal Nutrition Assistance[2].

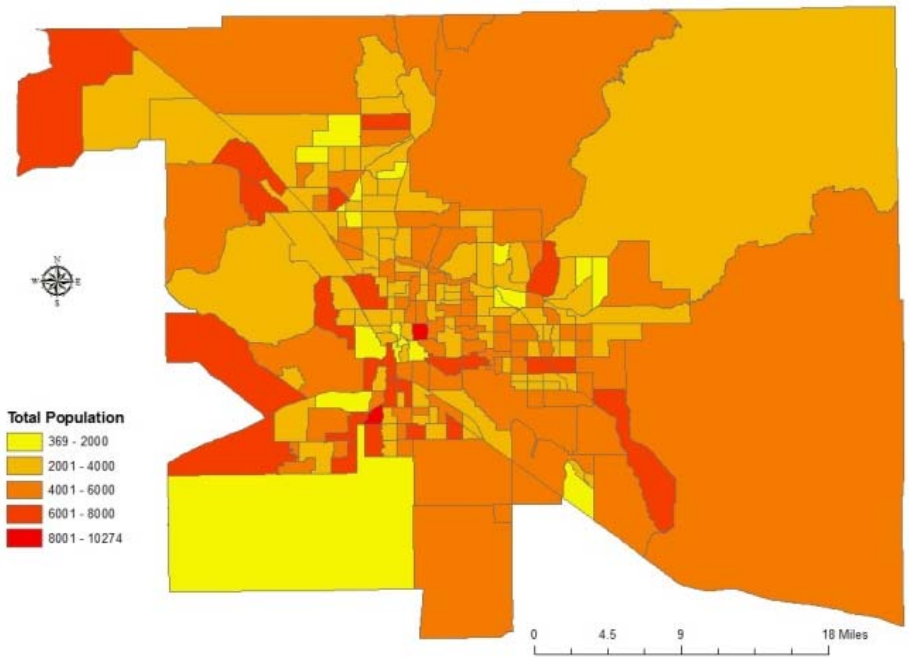
Within Tucson, dozens of non-profit organizations working to combat food insecurity exist. Most prominent of these organizations is the Community Food Bank of Southern Arizona, whose Feeding Program serves more than 14,000 meals per month (CFB 2015). In 2013, Charity Navigator named the Community Food Bank as one of the "10 Top-Notch Charities" nationwide. The Community Food Bank of Southern Arizona is currently targeting programs to feed the severely food insecure in Tucson while also building food literacy and accessibility through its Youth Farm and Community Gardens programs[3].

The Tucson metropolitan area has approximately one million residents, who mostly live in the city of Tucson and the surrounding suburbs (Figure 1a). The region has a rather diverse demographic profile: a large Hispanic population (Figure 1b), due to its proximity to the U.S.–Mexico border;

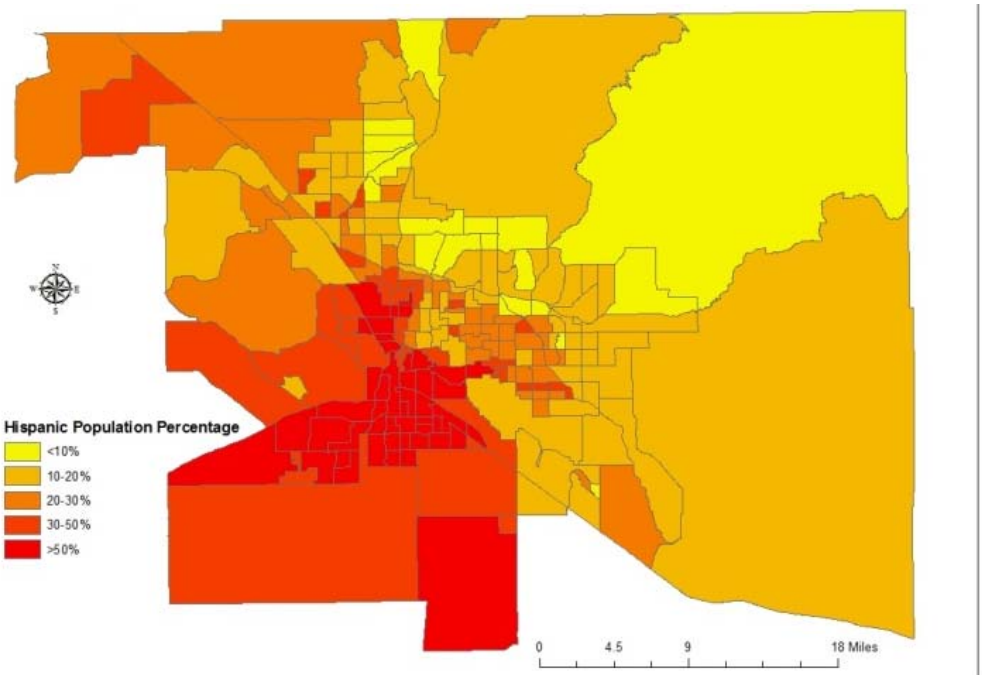
[2] Per Feeding America's *Map the Meal Gap 2014* Report, an individual or household must earn less than or equal to 185% of the poverty line to be deemed eligible for Federal Nutrition Assistance.
[3] For more detailed information about these programs, see the CFBSA's website at https://www.communityfoodbank.org/Programs-and-Services

a considerable seasonal fluctuation of migrants - retirees and snowbirds from the North in particular; and a sizeable college population, being home to the University of Arizona.

Figure 1 Demographic profiles in Tucson, AZ.



(a) Total population distribution



(b) Hispanic population percentage

3. Data Collection

The data collected in the study area includes geographic units of block groups and tracts with the associated socio-economic information (population, medium household income, etc.), street networks, chain stores, independent stores and farmers' markets. A summary of the data sources is provided in Table 1.

Table 1 lists of the data collected in this study.

Data	Source
Census block with population	U.S. Census Bureau 2010 SF1
Census block groups with socio-economic info.	U.S. Census Bureau 2010 SF1 and 2010 ACS 5-Year Estimates
Census tracts with socio-economic info.	U.S. Census Bureau 2010 SF1 and 2010 ACS 5-Year Estimates
Street networks	Pima County GIS Portal
Chain stores	Company Website and field work (2015)
Independent stores	ReferenceUSA & field work (2015)

As indicated in Table 1, while some data sets were obtained from the Census Bureau or Pima County, locations of chain stores were collected by visiting each chain's official website and using their store locator function in the broad Tucson area to ensure the latest and most accurate store information, as there have been multiple incidents of opening and close-out of supermarkets and large chain grocers in the last few years. Location information for all the chain stores was obtained, cross-checked, and then geo-coded in ArcGIS. A selective amount of stores were visited by the research team.

Locations of registered independent grocers in the urban area were first collected using ReferenceUSA and google search. Through field trips and ground-truthing, several additional stores were added and a few removed as they were found to be either closed permanently or wrongly registered. This resulted in a total of 45 independent food stores. Visits were then made to each store to collect more data about these stores.

A survey was designed to collect data about the 45 independent stores. The survey was divided into two parts: **General Observations** and **Food Variety & Price**. The **General Observations** section served to gather information about the conditions of the store: information regarding transportation, store layout, customer characteristics, and types of assistance offered by the store. The **Food Variety & Price** section served to gather data about the types of food (ethnic and non-ethnic) available and their associated prices. Data gathered in the survey served as a tool for comparison between independent grocers and markets in different geographic areas throughout Tucson. A description of the types of data gathered via the survey is provided in Section 5.

4. Food Access Data Analysis

4.1 Socio-economic characteristics and food store distribution

A total of 174 census tracts covering the city of Tucson and nearby suburbs are included in the study, which account for approximately three quarters (75%) of the county's population. Wide gaps are found in socioeconomic status among various ethnic groups and across different neighborhoods geographically. For instance, the average of median household income in the region is $49,648 (Census 2010); yet, at the tract level, it ranges from $9,832 to $125,545 (Figure 2). A closer look at the poverty level further reveals the spatial disparity. As shown in Figure 3, more than one third census tracts (60 out of 174 census tracts) are identified as high or extreme poverty areas, meaning that more than 20% of the tract population (over 40% in the case of extreme poverty areas) were reported living under the poverty line. These areas are found highly concentrated in the central part of the city and in the south. In contrast, people in the northern part of the region generally enjoy lower poverty rates (Figure 3) and higher income (Figure 2).

Figure 2. Household income distribution in Tucson, AZ.

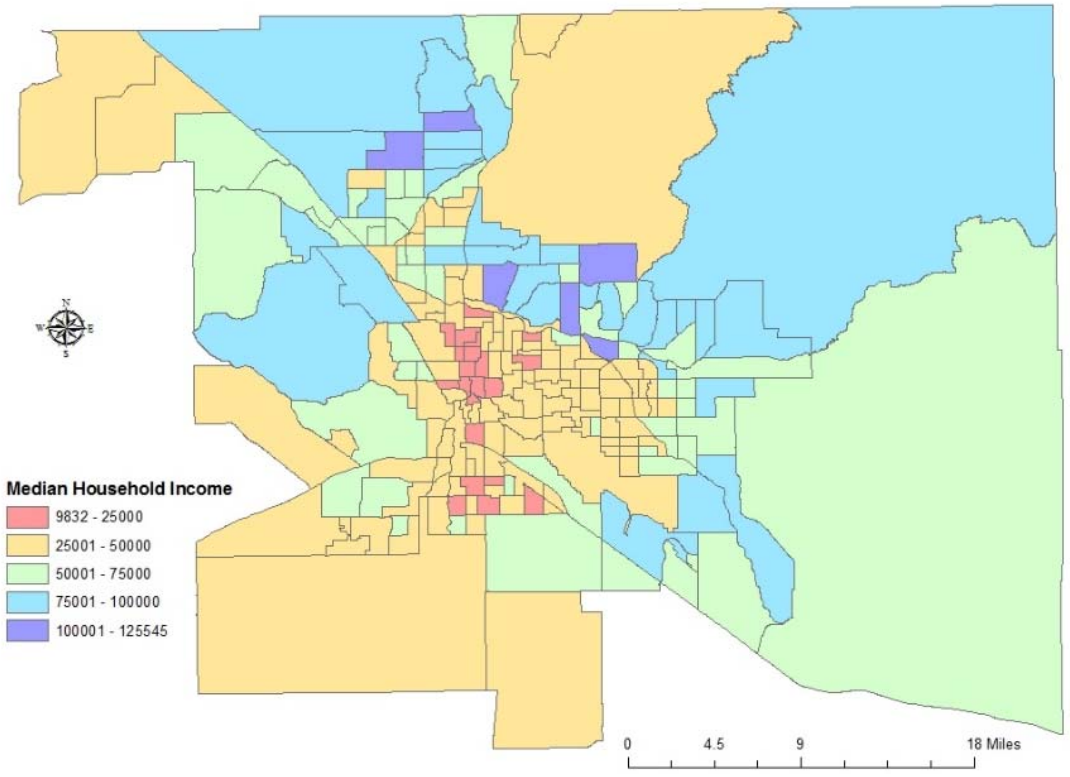
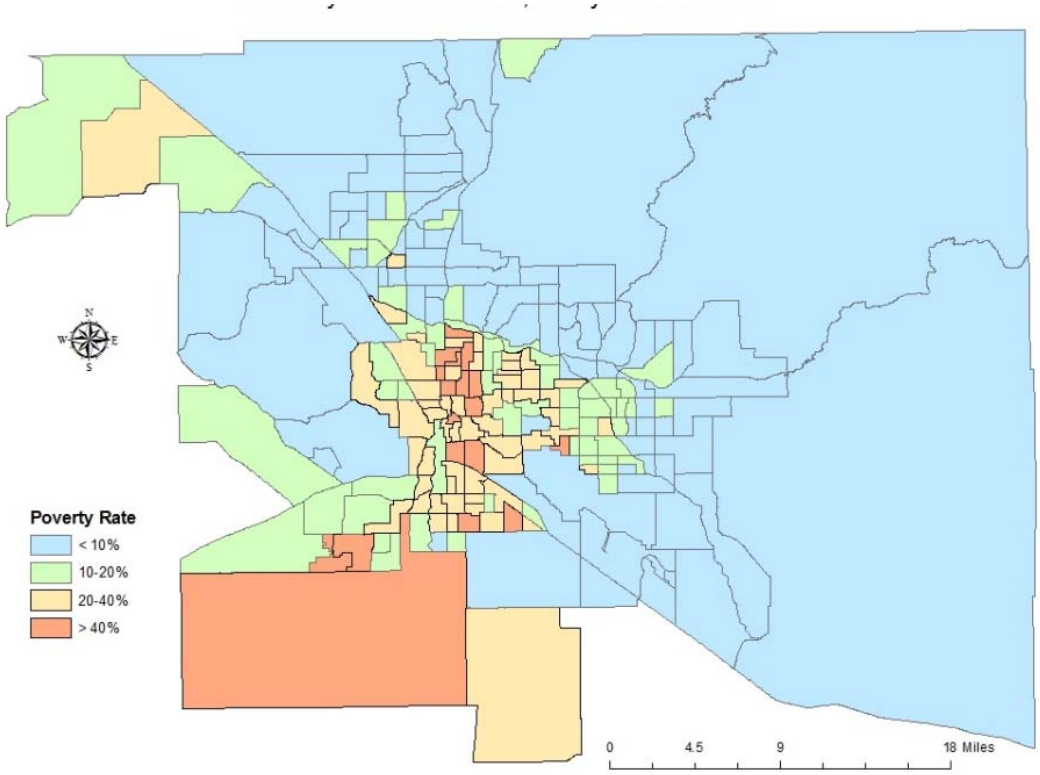
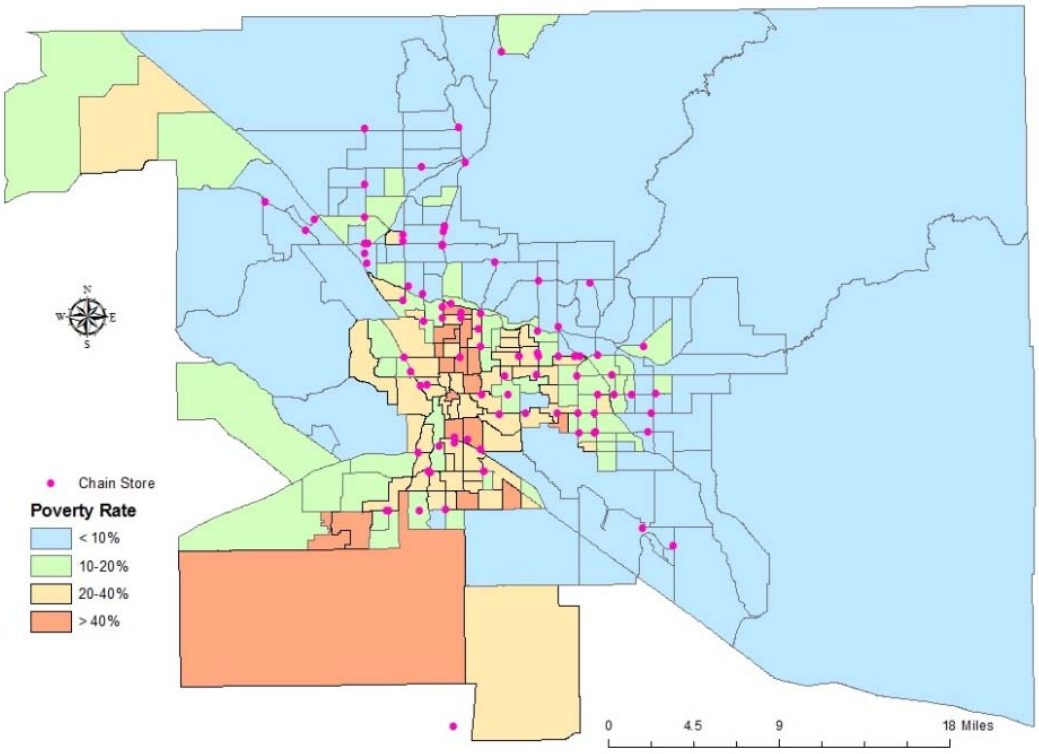


Figure 3. Poverty distribution in Tucson, AZ.



Spatial disparity is also found in service distribution, grocery stores in this case. Figure 4 shows the distribution of large national/regional chain stores in the region, such as Albertson's, Fry's, Safeway, and Food City, overlaid with the poverty distribution information. Even though grocery stores are more densely located in central part of the region, store density is much lower in the downtown area comparing to the surrounding neighborhoods. As one travels away from the city, fewer stores are available in the neighborhood. Yet the south and northwest with higher poverty rates suffer more compared to the north.

Figure 4. Grocery store distribution in Tucson, AZ.



4.2 Food deserts at the census tract level

As mentioned earlier, the identification of food deserts in the study area involves two major elements: low-income and low-access. According to the USDA, census tracts qualify as "low-income communities", based on having: a) a poverty rate of 20 percent or greater, OR b) a median family income at or below 80 percent of the area median family income. In this study, a poverty rate of 20% and greater is used to identify low-income communities. As mentioned in Section 4.1, 60 census tracts in the study area are considered low-income communities.

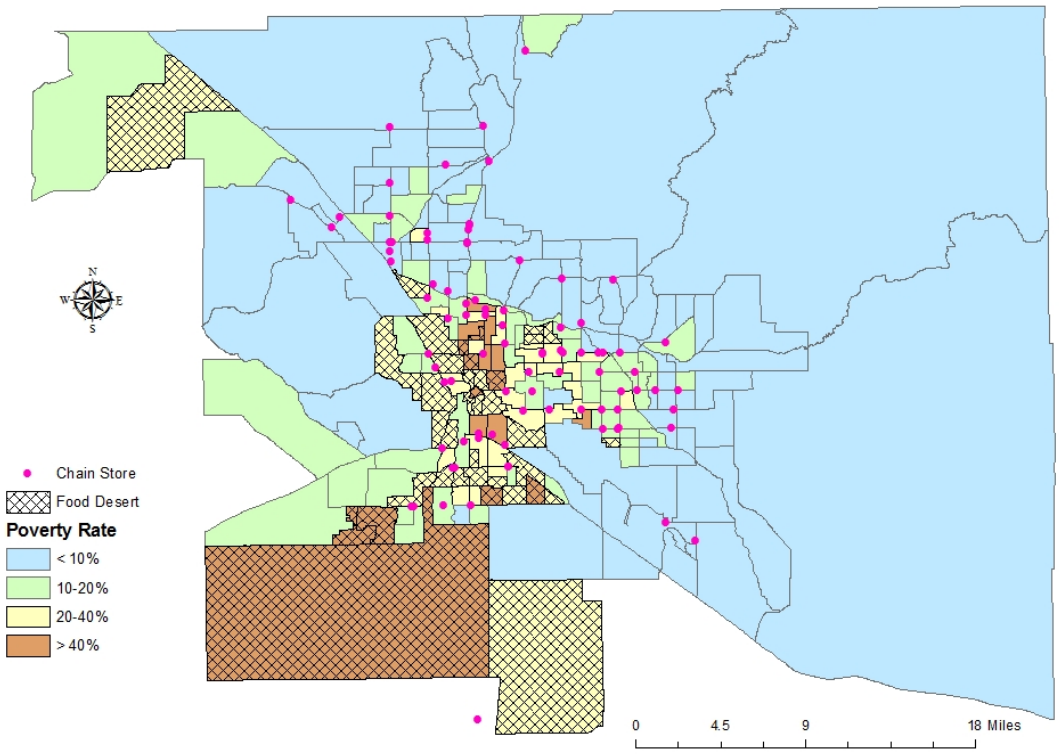
We also followed the 1-mile threshold suggested by the USDA for identifying "low-access" in urban settings. In terms of the type of stores that qualify "fresh, healthy, and affordable food outlets", USDA follows the industry-standardized definition of a supermarket.

Applying these two criteria, a total of 38 census tracts[4] are identified as urban food deserts, where distance to the closest supermarket or large grocery store is more than 1 mile and more than 20%

[4] The food deserts found in this study can be different from those identified by the USDA although the same criteria have been used. For ERS (USDA) estimates, on the one hand, the list of supermarkets and large grocery stores was developed based on food store directories from the year 2006; in comparison, we used up-to-date data on the food store information. On the other hand, the building blocks used for identifying food deserts at the census tract level by USDA are the 1-square-kilomenter grids derived by the Socioeconomic Data and Applications Center (SEDAC). We note the 1-square-kilometer grid based method can be problematic and can introduce a substantial amount of

of the residents live under the poverty line. A total of 156,278 people have been found to reside in food deserts in the study area and 41% (63,566) are Latino. As shown in Figure 5, most food deserts are located either around the downtown area or in the south, where poverty rate is rather high. There is also one tract in the Northwest that is considered to be food desert.

Figure 5. Food deserts I by census tract in Tucson, AZ.



While many studies tend to rely on only large supermarkets for identifying "food deserts", we also examined whether independent stores, such as ethnic stores and Mom-n-Pop stores, help alleviate food deserts at the census tract level. As shown in Figure 6, most independent stores are scattered around the center of the city. Quite a few are also found in the south where the Hispanic population is large while there are a few in the north as well. It is clear that the presence of independent stores fill the food service gap in the downtown area, when chain and independent stores are both mapped (See Figure 7).

error in the analysis process. The socio-demographic data available at the block group level is first disaggregated to blocks and then allocated aerially to roughly 1-square-kilometer grids (Dutko et al. 2012). In the process of disaggregation and aggregation, error inevitably occurs.

Figure 6. Independent store distribution in Tucson, AZ.

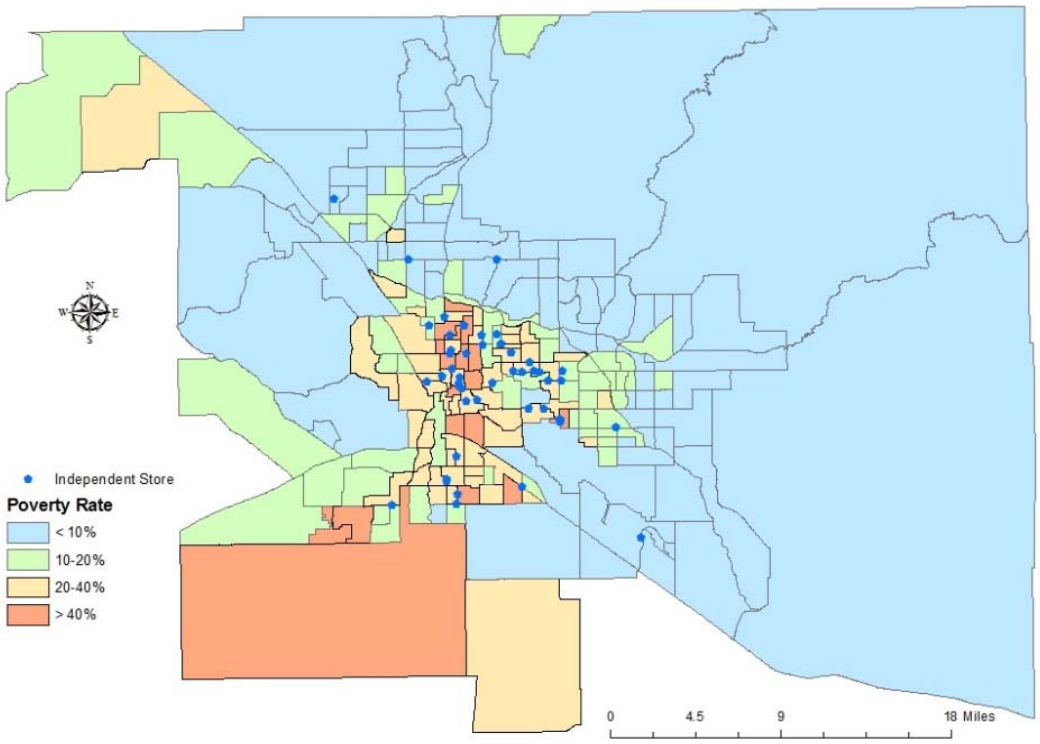
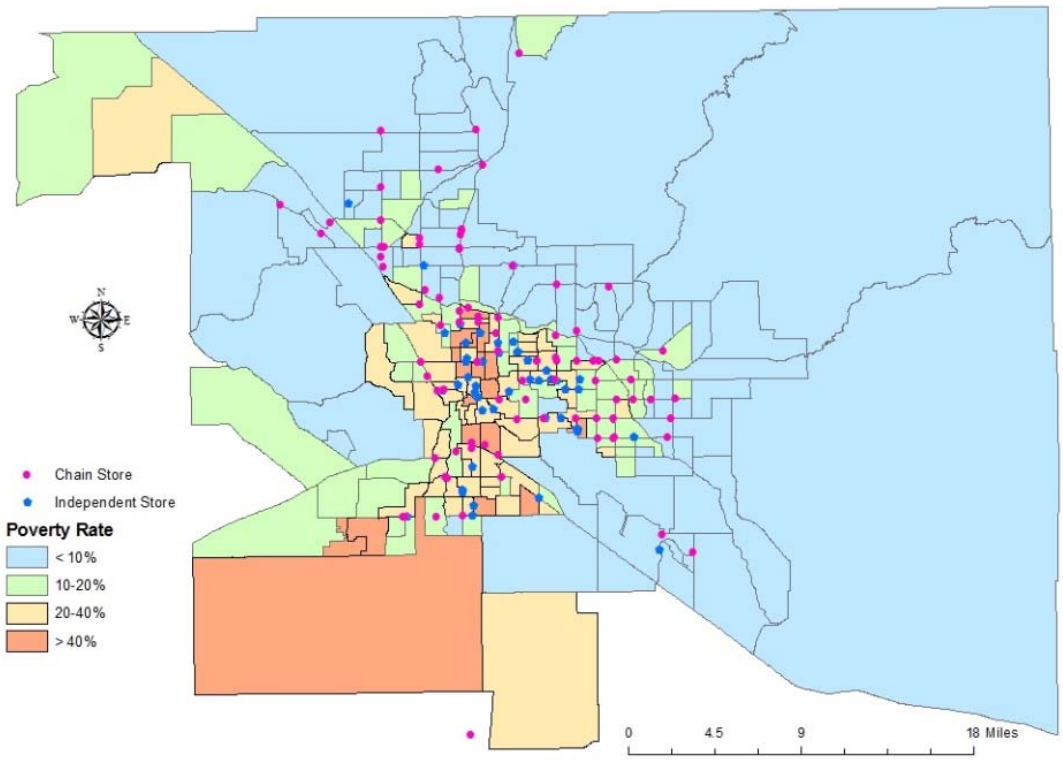
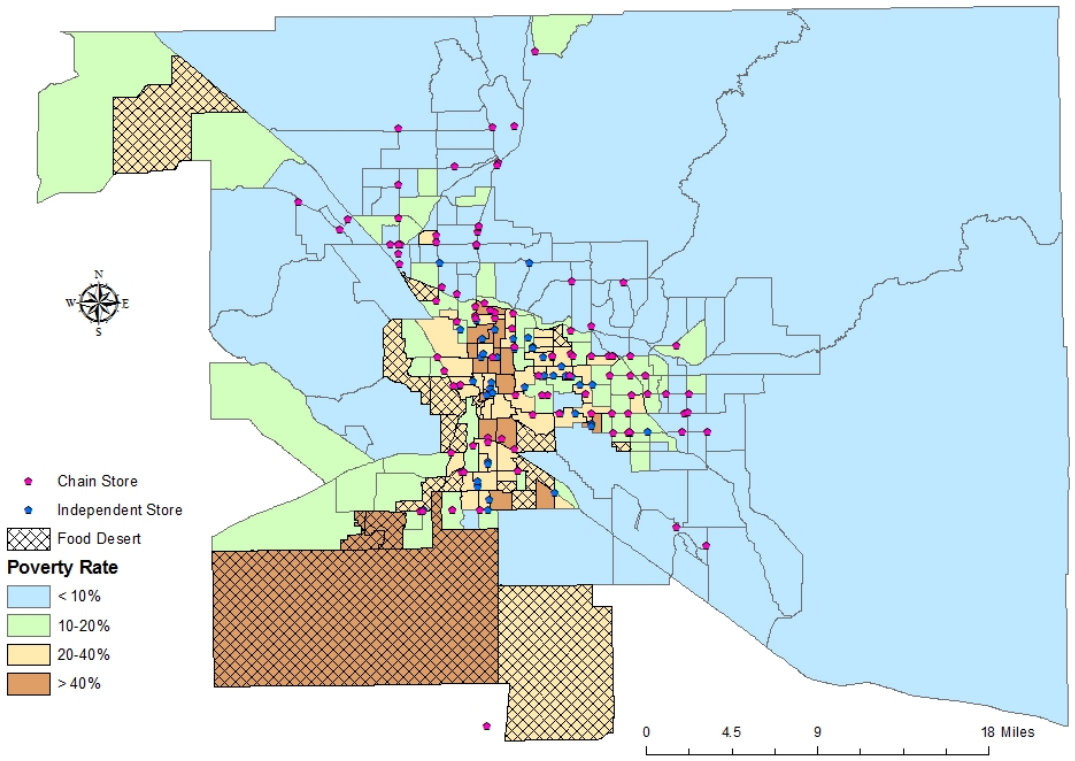


Figure 7. Chain and independent store distribution in Tucson, AZ.



Computation was also conducted for identifying food deserts by treating both chain and independent stores as qualified "fresh, healthy, and affordable food outlets". A new food desert map was generated (see Figure 8) which has included independent stores as a food access point as well. The inclusion of independent grocery stores has significantly increased the number of food outlets (by 45%). The number of food deserts decreased from 38 census tracts to 19 tracts, representing a 50% decrease. The total population who reside in food deserts are 81,459 when independent stores are introduced, comparing to the previous amount 156,278 when only chain stores are considered. In other words, independent stores have improved the food access of 48% of the food desert population. Although the identified Hispanic population living in food deserts decreases from 58,305 to 39,169, comparing with the overall amount in food deserts the percentage of Hispanic has actually increased from 41% to 48%. That is to say, the non-Hispanic population benefit more from independent stores in terms of improved food access.

Figure 8. Food deserts II by census tract incorporating independent stores in Tucson, AZ.



As mentioned earlier, independent food stores are more densely distributed in and around downtown Tucson. As a result, communities centered around the downtown area, which were previously identified as food deserts when only chain stores were considered, are no longer food deserts when independent stores are introduced. Other independent stores, which co-exist with chain stores in areas where demand is high and therefore perceived profitable by business owners, however, had little impact on changing the landscape of food deserts. Still, the presence of

independent stores in those areas helps improve food accessibility by offering more choices in the neighborhood and a diversity of food items, ethnic food, for instance.

4.3 Alternative Food access assessment

In addition to the drawback of excluding local full-range grocery stores that does not necessarily have an annual sale of 2-million and above, the USDA's binary 1-mile cutoff based method is limited in measuring the ability to access food in general. We note that food access is related to a rather broader question of accessibility assessment. While food deserts are defined based on the distance to the nearest supermarket (availability), accessibility measures based on other aspects were also examined in this study. In addition, we measured travel along real road networks when quantifying food accessibility, which is more accurate than a straight-line (Euclidean) distance that may give an overestimate of food accessibility given that Euclidean distances are normally shorter than network distances.

More specifically, three measures developed by Apparicio et al. (2007) and Larsen et al. (2008) were used in this study to examine food access in Tucson, AZ. Measure I is a proximity measure, which evaluates the distance to the nearest grocery store. Measure II is a variety measure, which counts the number of grocery stores within 1 mile in an urban area. Measure III is a diversity measure, which assesses proximity to three nearest stores under different chains/brands. This measure also reflects the degree of spatial competition among different chains. The formulas of the three measures are as follows:

Measure I (Proximity):

$$D_t^1 = \frac{\sum_{b \in Mt} p_b d_b}{\sum_{b \in Mt} p_b} \qquad \textbf{(1)}$$

Where:
D_t^1 is the mean distance of census tract *t* from the nearest grocery store;
b is the index of blocks
M_t is the set that contains all the blocks in tract *t*
p_b is the total population in block *b*
d_b is the distance from the centroid of block *b* to the nearest store.

Measure II (Variety):

$$N_t = \frac{\sum_{b \in Mt} p_b s_b}{\sum_{b \in Mt} p_b} \qquad (2)$$

Where:
N_t is the mean number of grocery stores within a designated distance (i.e. 1 mile) of tract *t*
s_b is the number of stores within a designated distance (i.e.1 mile) of block *b*

Measure III (Diversity):

$$D_t^2 = \frac{\sum_{b \in Mt} \sum_{j=1,..,n} p_b d_{bj}}{n \sum_{b \in Mt} p_b} \quad (3)$$

Where:

D_t^2 is the mean distance between census tract t and stores under *n* different chains;

d_{bj} is the distance between block *b* and the closest store under Chain *j*

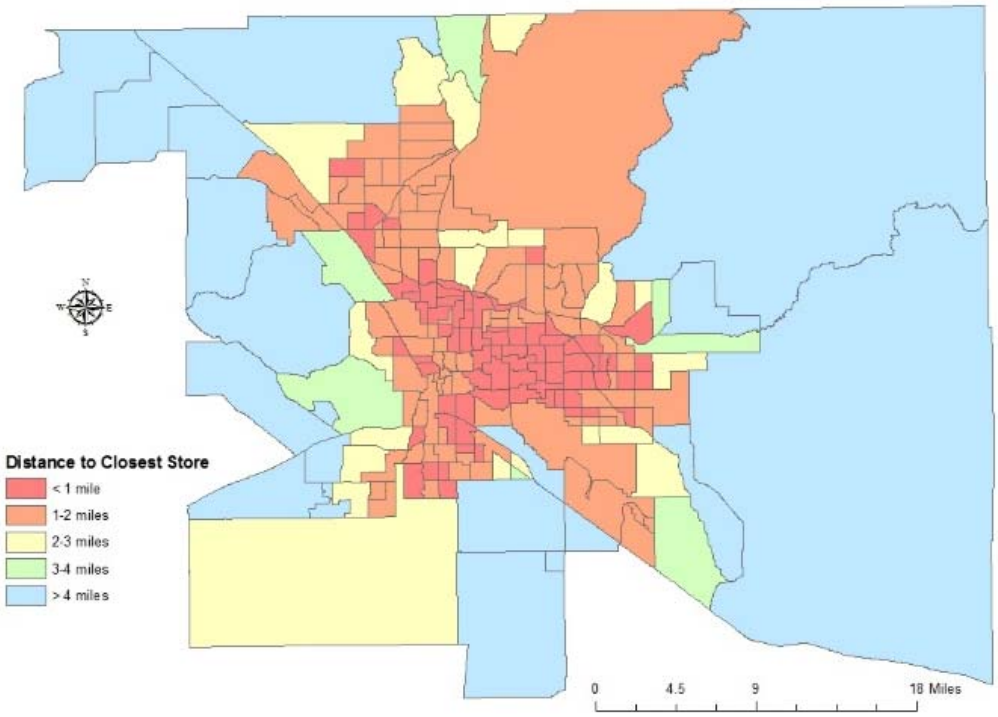
n is the number of different chains (n=3 is used in this study)

All three measures above use census block, the smallest census unit, as the building block to measure distance or count number of stores. According to formulas (1)-(3), they are aggregated to the tract level, using block population as weights in the aggregation process. In other words, population-weighted average measures at the block level are transferred into census tract level measures of accessibility. It has been argued that this method minimizes aggregation error and can better account for the spatial distribution of population (Hodgson et al. 1997; Hewko et al. 2002; Apparicio et al. 2008). Besides, tract level measures are less computationally intensive comparing to block level measures, especially in large areas. For example, in the study area a tract level evaluation involves only 174 census tracts, as opposed to 14,561 blocks.

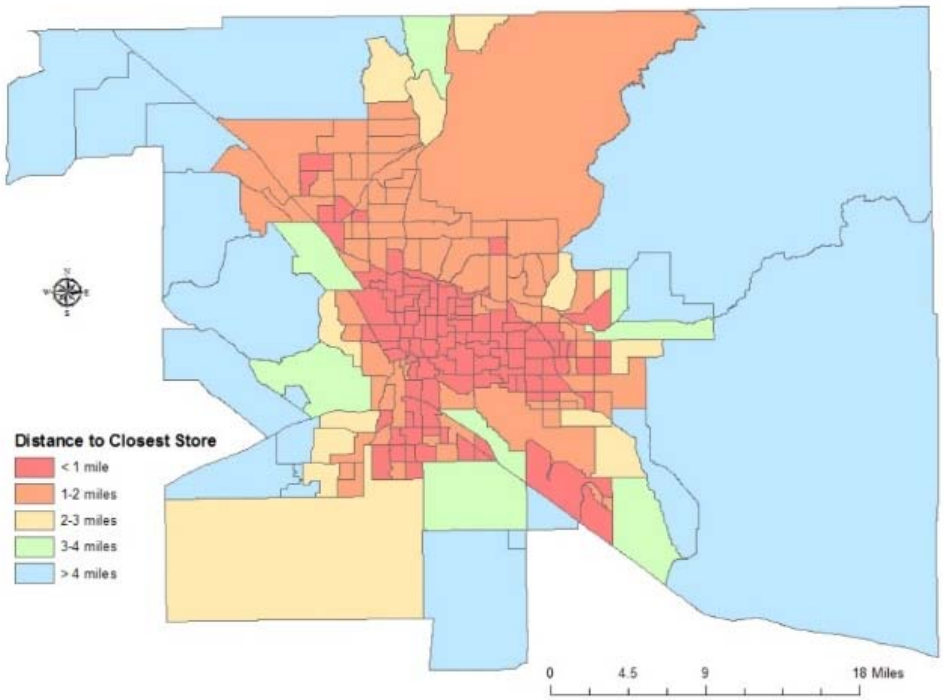
All the distances in (1) to (3) were measured based on travels along real road networks in Tucson, AZ. For Measure I – Proximity, the mean network distance to the closest grocery store for the whole region is about 1.9 miles. Figure 9 maps the food access patterns based on chain stores only (Figure 9a) and that based on a combination of both chain and independent stores (Figure 9b). Both Figures 9a and 9b indicate great spatial disparities across different parts of the region. An overwhelming proportion of census tracts in the central part of the region, including the near east, have a grocery store within 1 mile travel distance range, which can be viewed as high access. In contrast, areas in far eastern and western locations are considered to be low access where Tucson residents have to travel more than 4 miles to the closest grocery store.

Comparison of Figure 9a and 9b indicates that the inclusion of independent stores as a fresh, healthy food outlet has visibly improved immediate food access. For example, more areas in Figure 9b fall into the category of having the closest store within the 1-mile radius, especially in the city of Tucson. Similar improvement can be found in the suburbs as well, for example, in the center north, southeast and northwest. For the whole region, the average distance to the closest store decreased from 1.86 miles to 1.66 miles when independent stores are included. Most changes occurred in the city and some in nearby suburbs.

Figure 9. Food access based on Measure I – Proximity by census tract.



(a) Chain stores only

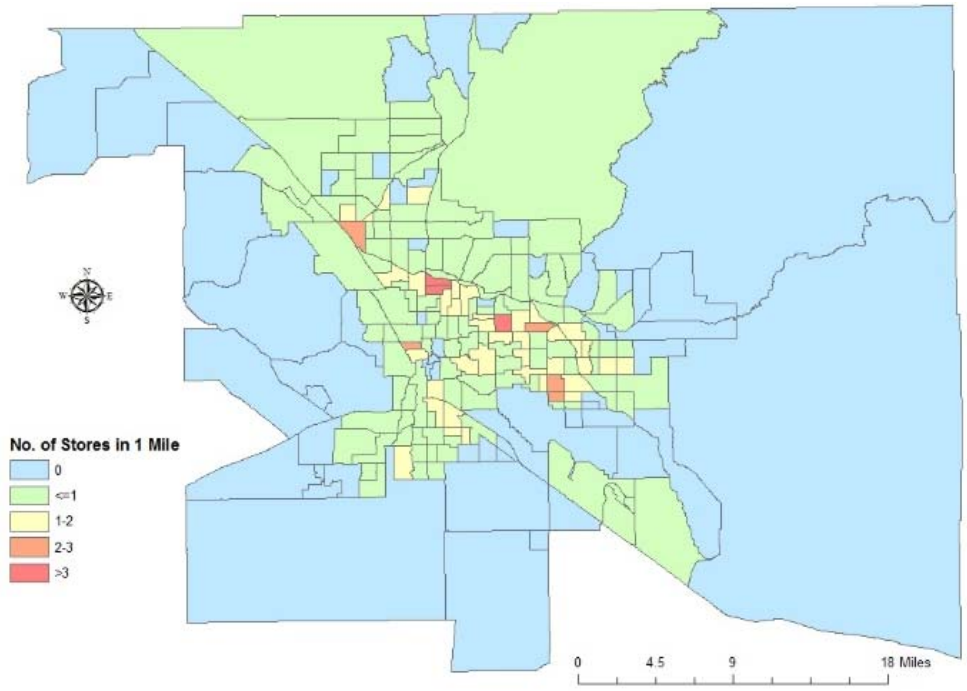


(b) Chain and independent stores

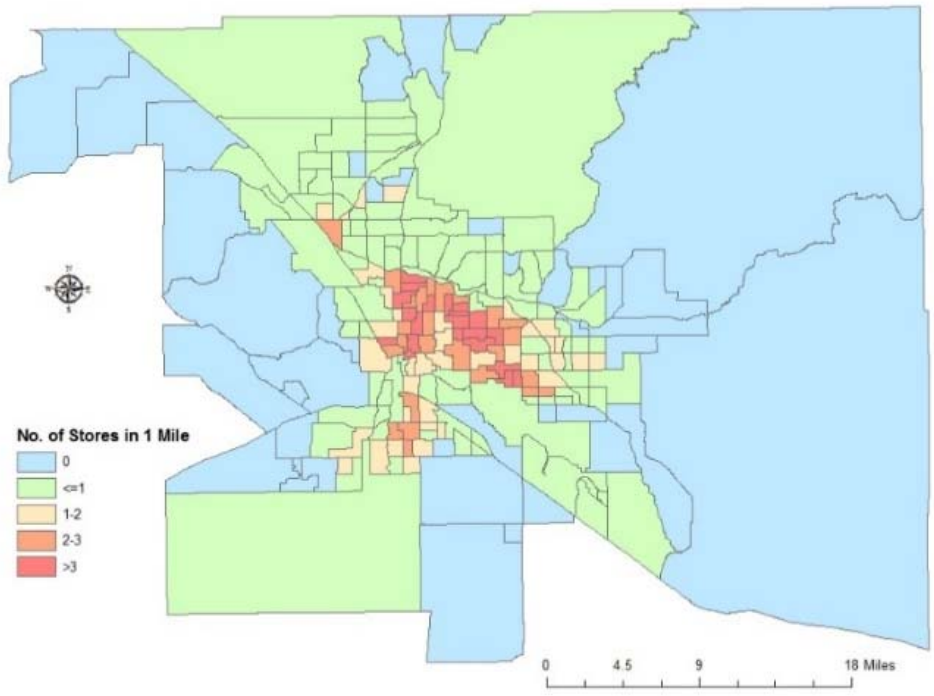
For Measure II – Variety, spatial disparities are rather striking. Figure 10 depicts the mapped patterns for chain stores only (Figure 10a) and the combination of both chain and independent stores (Figure 10b). Although the average number of stores in the 1 mile range for the entire region is 2.4, one can see in Figure 10 (particularly Figure 10a) that the majority of the study area does not have any grocery store or has less than 1 grocery store within 1 mile. Only a handful of tracts in the center of the city have multiple grocery stores within a 1 mile radius. The comparison of Figure 10a and 10b also shows significant improvement of food accessibility as independent stores have provided choices of food shopping alternatives. It is highly noticeable that almost all census tracts in central Tucson have witnessed substantial changes in terms of number of stores available in the 1 mile travel range. Changes are also found in the south and southwest, where most areas have less than 1 chain store within the 1 mile distance.

Measure II indicates a very interesting aspect of food accessibility that is quite different from Measure I. Some areas may enjoy good access in terms of immediate proximity (Measure I), but they rely on the only store, the closest one according to Measure I, in the neighborhood. Yet, in reality, people do not necessarily only visit the closest store but instead select the store they shop in by product assortment, brand preference, price, and availability of public transportation, ethnic food and other services. During our study, we noticed that some recent immigrants who live at Alvernon Avenue and 29th Street need to take public transportation to the Lee Lee International Supermarket at the Orange Grove Road and La Cholla Boulevard for regular grocery shopping. The overall travel distance is about 15 miles with a travel time of approximately two hours by bus involving one or two bus transfers depending on the buses they use. Another example is the extent to which high-end organic stores, like Whole Foods, serve the local community. In the study area, we also noticed that some higher-priced stores are not necessarily located in the most affluent neighborhoods; instead, they are on major roads where traffic flow is high-very likely catching commuting workers from their work place to their home location. In this case, even though the store itself is the closest store to the very neighborhood where it is located, it does not necessarily serve the entire local community. Residents travel a longer distance to the second closest or the third closest store within a reasonable range. Therefore, Measure II conveys a different facet of the food access characteristics and environment that supplements Measure I.

Figure 10. Food access based on Measure II – Variety by census tract.



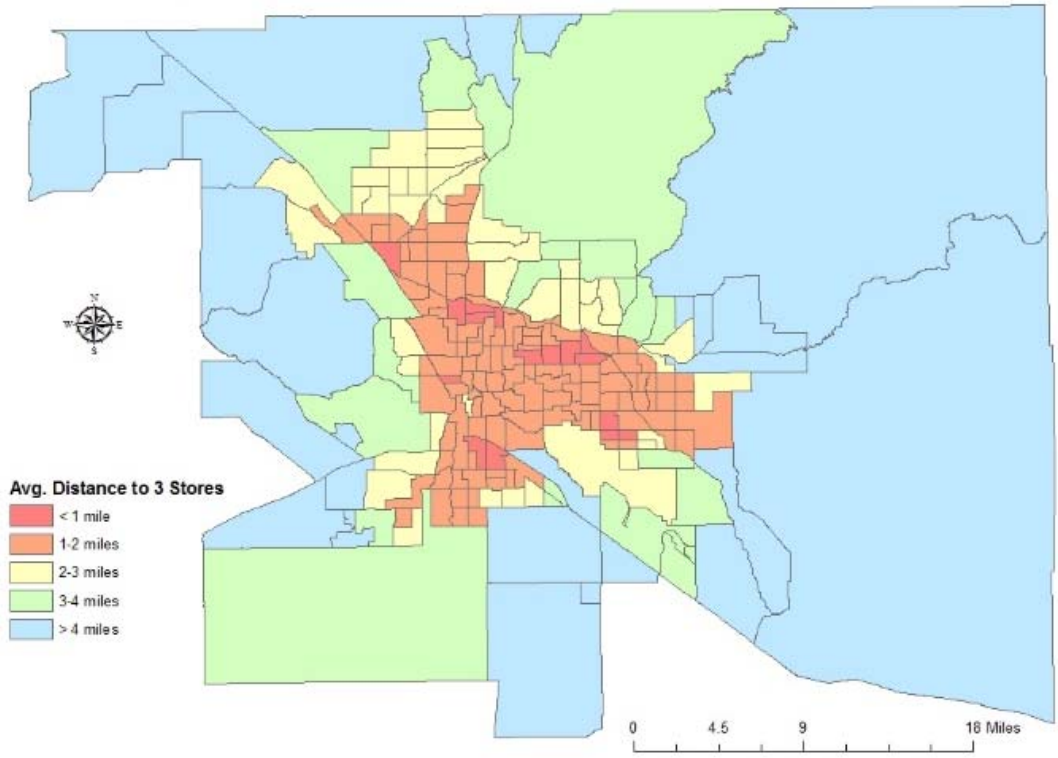
(a) Chain stores only



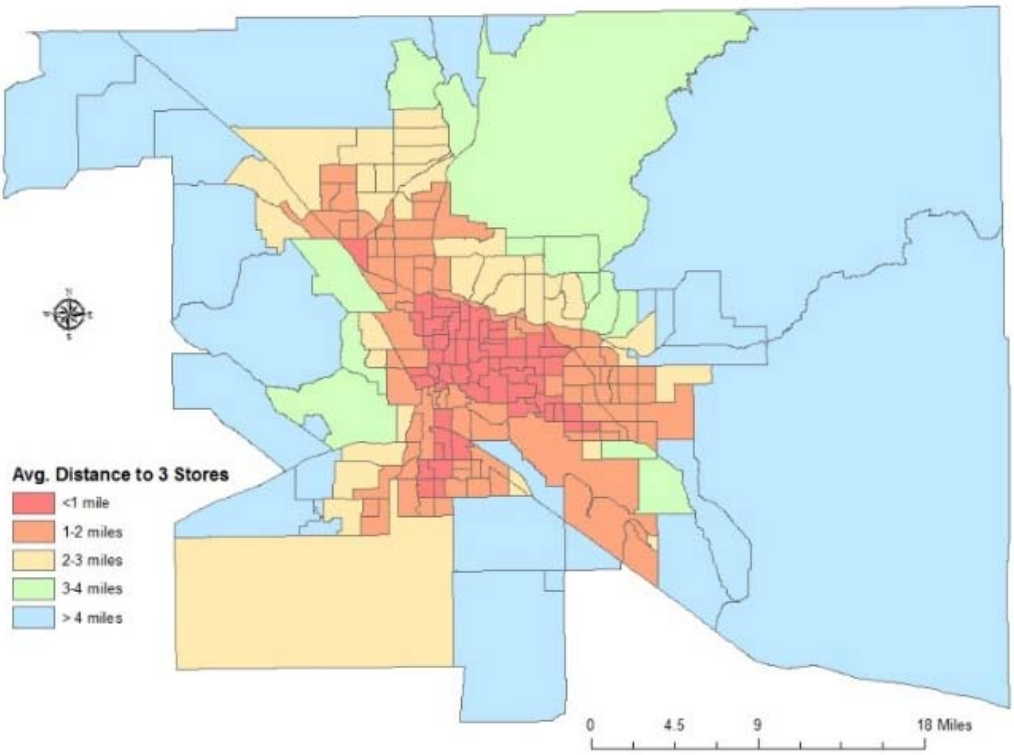
(b) Chain and independent stores

For Measure III– Diversity, the average travel distance to the closest three stores is found to be approximately 2.4 miles, comparing to 1.9 miles to the closest store according to Measure I– Proximity when only chain stores are considered. In general, Measure III (Figure 11) presents a similar pattern as Measure I. However, upon closer examination, one will notice that certain areas may not have good access in terms of immediate proximity (Measure I), yet they enjoy rather diverse access in terms of different store choices in the surrounding neighborhoods (Measure III). On the other hand, some areas enjoy high proximity to a single store in the area, but have comparatively low values according to the diversity measure (lack of alternatives in the neighborhood) – similar to Measure II. In addition, we also see a considerable number of census tracts that have boosted from lower level of accessibility categories to higher levels when independent stores are also considered (Figure 11b). Again, the whole downtown area and central Tucson display great improvement in terms of diversity – with multiple stores in close range.

Figure 11. Food access based on Measure III – Diversity by census tract.



(a) Chain stores only



(b) Chain and independent stores

Table 2. Summary statistics of the three measures with and without the independent stores at the census tract level

Accessibility	Measures	Population		Change	
	Dist. to the closest store	Chain stores only	Chain & independent Stores	Population	Percentage
High	<1 mile	316170	416054	99884	31.59%
Medium High	1-2 miles	365845	298153	-67692	-18.50%
Medium	2-3 miles	81874	52119	-29755	-36.34%
Medium Low	3-4 miles	25703	34177	8474	32.97%
Low	> 4 miles	98577	87666	-10911	-11.07%
	No. of stores in 1 Mile	Chain stores sonly	Chain & Independent Stores	Population	Percentage
High	>3	13959	84132	70173	502.71%
Medium High	2-3	19070	105955	86885	455.61%
Medium	1-2	150492	146183	-4309	-2.86%
Medium Low	0-1	490970	384753	-106217	-21.63%
Low	0	213678	167146	-46532	-21.78%
	Avg. dist. to 3 closest stores	Chain stores only	Chain & Independent Stores	Population	Percentage
High	<1 mile	63700	233365	169665	266.35%
Medium High	1-2 miles	451614	343508	-108106	-23.94%
Medium	2-3 miles	161203	131535	-29668	-18.40%
Medium Low	3-4 miles	92196	60305	-31891	-34.59%
Low	> 4 miles	119456	119456	0	0.00%

Table 2 provides a summary of the food access assessment based on the analysis scale of census tract. Independent stores demonstrate consistency in improving food accessibility with a positive change observed for the high accessibility category across all the three measures. The improvement is most significant with Measure 2 (the variety measure). When independent stores are introduced, the number of people found in the categories of high access and medium high access increased 4.5 to 5 times. This is followed by Measure 3 (the diversity measure) where the high access category is found to include twice as many people. Measure 1 (the proximity measure) has the least amount of improvement among the three, but still shows that 31% more people are introduced into the high access category. Similar to the findings based on Figures 9-11, Table 2 also suggests that independent stores help improve food access by significantly broadening alternative food access choices in the neighborhood.

4.4 Food access measured at the block group level

All the maps have been generated based on the geographic units, census tracts by assuming that they represent the building blocks of communities and neighborhoods. However, looking at all of the maps, it is clear that a substantial degree of variation exists in the size and shape of these tract based units. Generally speaking, tracts inside the city are much smaller than those in the suburbs. Therefore, food access assessment based on census tracts may contain a significant amount of uncertainty due to the coarse scale used in the analysis. The following analysis presents the food accessibility measures at a finer resolution of geographical units - the block group level to evaluate the sensitivity of the analysis due to scale.

The introduction of finer geographic units resulted in three new food access maps (Figures 12-14) based on the combination of chain and independent stores using the three food accessibility measures (Measures I, II, III). In general, it appears that food accessibility at the block group level shows a similar pattern as that at the census tract level. Food accessibility is high in the center of the city and immediate suburbs. However, when zooming in, one will notice that more detailed geography (transitioning from tract to block group) comes with a more realistic representation of food accessibility. For instance, when measured at the tract level, a tract that is within the range of 1-2 miles to the closest grocery stores may be split into different parts at the block group level: part of the tract is still classified as high accessibility with a grocery store located in a 2 mile radius, whereas the rest of the tract is no longer considered high-accessibility, as residents must travel 2-3 or even more miles to the closest food outlet.

In short, while some areas may have moved up in the distance grouping (for example, being in category of 3-4 miles to the closest grocery store at the census tract level vs. being classified as 2-3 miles to the closest store at the block group level), others move down the category. This type of change is due to the varying size of tracts, the relative locations of the food outlets to the centers of geographic units used, and the distribution of the residential population (which plays a weighting role) among other factors. It indicates that at the tract level, within-region variation could be substantial. Measures at a finer resolution, the block group in this case, minimize the differences and provide a more realistic representation of food access assessment.

Figure 12. Measure I – Proximity by block group

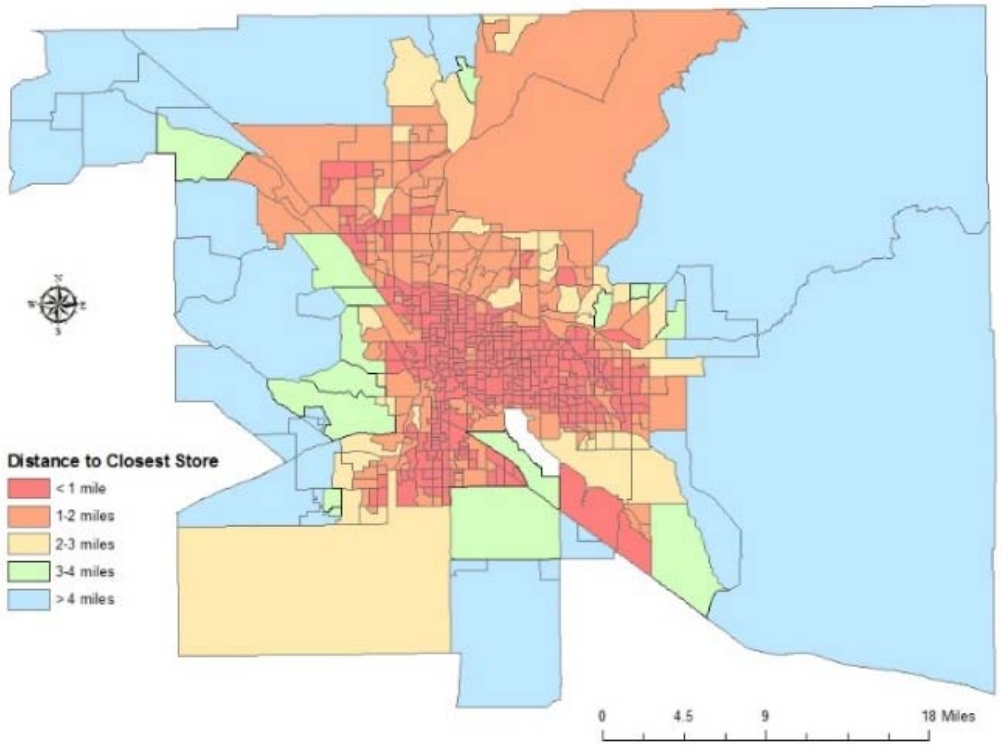


Figure 13. Measure II – Variety by block group.

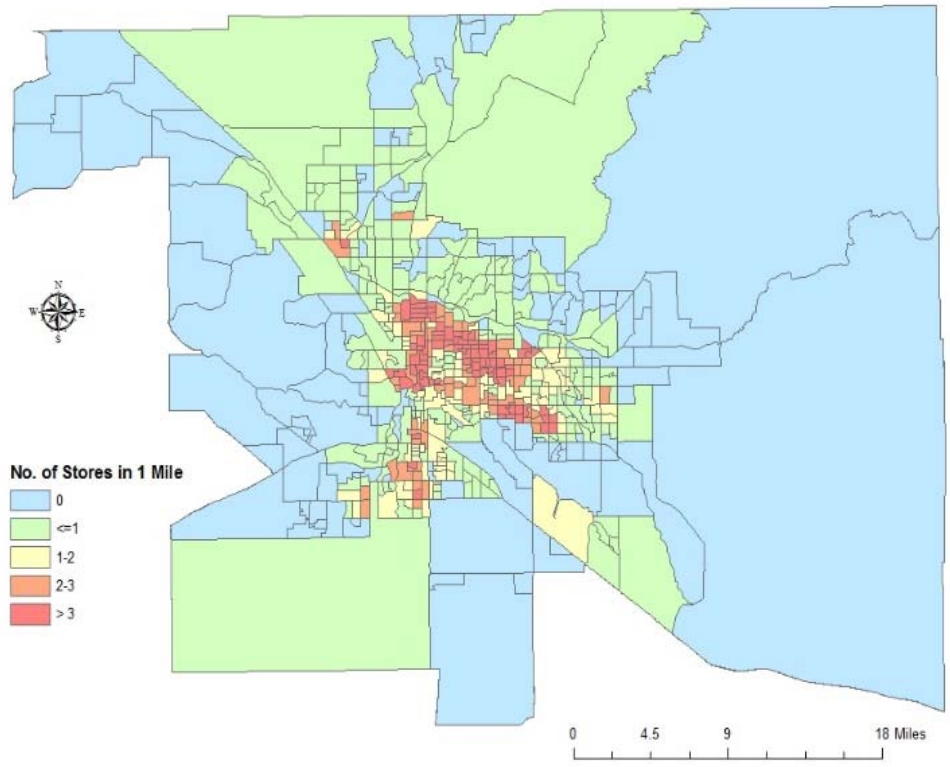
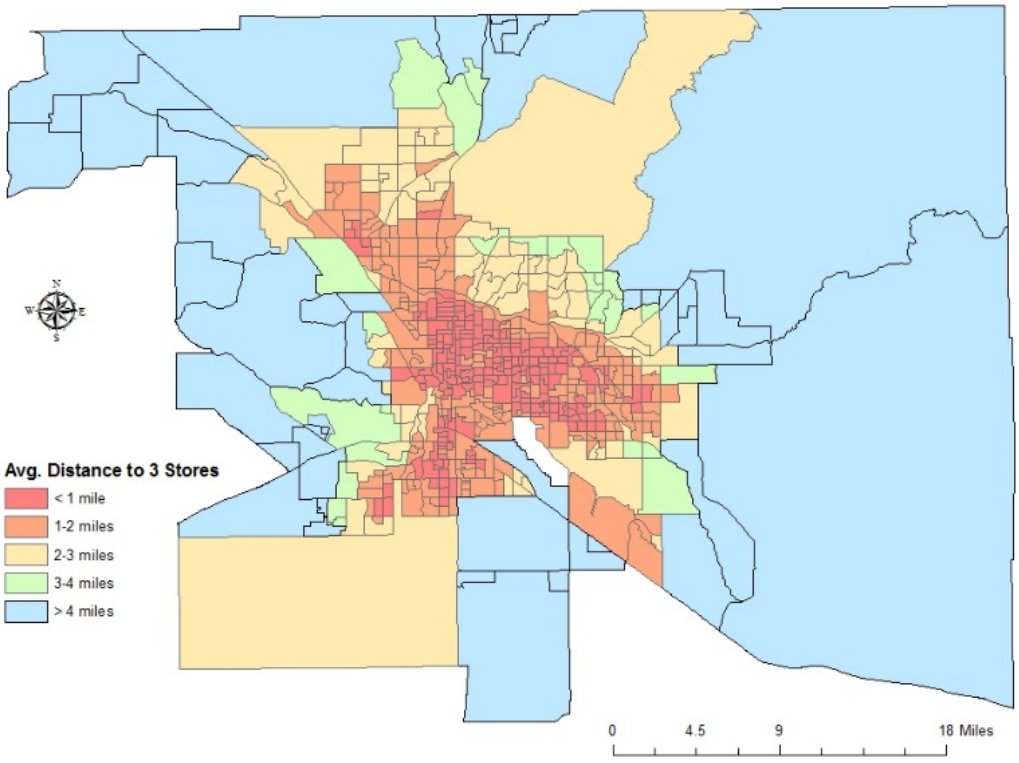
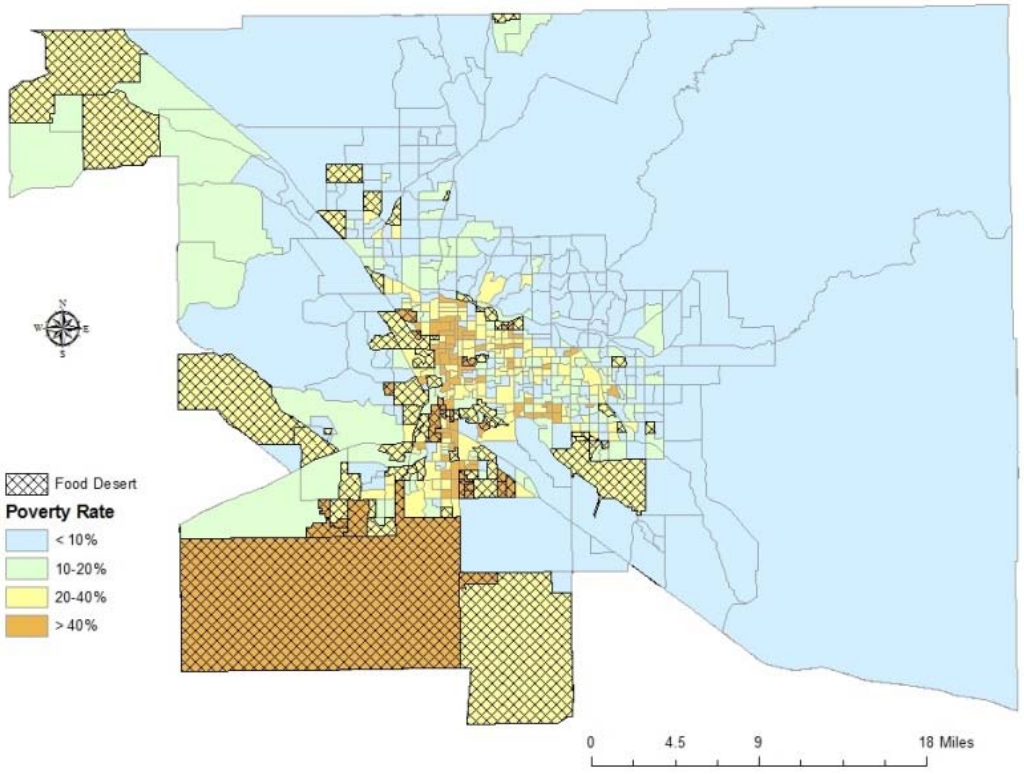


Figure 14. Measure III – Diversity by block group.



A map of food deserts identified based on block groups is shown in Figure 15. Analysis of Figure 15 resulted in more people (125,367) being classified as living in food deserts at the block group level compared to the number (81,459) at the tract level. In this case, analysis at the coarser scale, the tract, has led to an underestimate of the number of neighborhoods and people in food deserts.

Figure 15. Food deserts III at the block group level in Tucson, AZ.



5. Independent Store Data Analysis

As mentioned above, 45 registered independent grocers were located through ReferenceUSA and google search and ground-truthing was used to verify that these were still open. Visits made to each store were then used to collect data about these stores. The survey, divided into **General Observations** and **Food Variety & Price** was applied in each store. The **General Observations** section served to gather information about the store: information regarding transportation used by most customers to reach the store, store layout, customer characteristics such as clothing, and types of government food assistance listed on signs as accepted by the store. The **Food Variety & Price** section served to gather data about the types of food (ethnic and non-ethnic) available and their associated prices. Data gathered in the survey served as a tool for comparison between independent grocers and markets in different geographic areas throughout Tucson.

General profile-observations outside the store and at the entrance of the store, including vehicle information (makes, models, signs of age or rust), means of transportation, items displayed near store entrance and whether additional businesses like restaurants or gift stores existed within the market. Information about general customer characteristics was also gathered, including approximate age, sex, and race/ethnicity. This information was gathered through observations. Observations about general customer clothing and signs of poverty were also made.

(2) *Language*-Data about the languages spoken by cashiers and in signs displayed in the store was gathered. This was done by speaking with cashiers and store staff, and also by observing the languages of signs at the entrance windows of stores. (3) *Government assistance*-Data about whether stores accepted WIC, Food Stamps or other types of government assistance. This data was typically gathered in person through conversations with store staff/cashiers, or through observing indicators on store windows or product price tags. (4) *Assortment*-Data was gathered about whether stores offered items in small package sizes and/or in bulk sizes.

Variety & Price: Data about food variety and price were gathered at each store location. This data concerned the categories of food available, the prices of specific food items, including fresh vegetables and food. Data about the availability of organic foods were gathered, although no price data on these foods were collected. The research team also collected data about the availability, variety and price of frozen vegetables, canned vegetables, dry beans and canned beans. A large proportion of the stores had ethnic foods available, and data about the types of ethnic food available were gathered. Options included ethnic vegetables, fruits, fresh or dried herbs, meat, dairy, canned ethnic foods, and frozen ethnic vegetables.

Using a standardized store check-list, individual members of the research team noted observations of "**General Observations**" category. Data about store participation in government assistance programs were gathered through conversations with store staff, mainly cashiers. To collect "**Variety & Price**" information, research team members conducted store walkthroughs, where they recorded data about the availability, variety and price of different food categories within the store. An analysis of the main findings gathered via the survey is provided below.

The main findings related to food access are the availability of some items in small packages that make them more affordable and the availability of bulk items that are cheaper per unit. Most of the stores have items not available in other types of food outlets such as ethnic foods. These foods include fresh produce like different kinds of chilies and Asian vegetables as well as avocados and green papayas and ethnic teas, sweets and cheeses. Some of these stores offer bulk quantities of ethnic fresh and packaged foods. Examples of foods offered in bulk include olives, tortillas, rice, noodles, spices, sorghum and dried fruit. In terms of cheaper foods, beans such as pinto, black, garbanzos and lentils were offered by nearly all of the stores for low prices. Independent food stores had prices for items such as cheese, milk, eggs, and basic produce that were competitive with supermarket prices (see Appendix A). Fruits like limes, lemons, bananas and oranges were ubiquitous in the stores whereas other fruits like apples were rarer and, if available, more expensive. Meat stores tended to have the greatest variety of fruits and vegetables. Green leafy vegetables were also available at a small handful of stores only. Almost all of the stores accept food stamps and about three-fourths accept food stamps and one other form of assistance, mainly WIC.

Access to some of the independent stores is easier by foot, bike or bus than to chain stores due to the fact that most of the independent stores are located within neighborhoods. Some stores are located near bus stops. Most of the stores are also accessible by car and had small parking lots.

Other ways these independent stores benefit Tucson residents are the foreign languages that many of the cashiers and other store employees speak and the price and product signs in other languages located throughout the store. Spanish, Hindi, Chinese, Korean, Arabic, Somali, French and Russian languages were the most common (in that order). Cashiers and other employees frequently knew the customers by name and chatted with them. Many of the stores also sell ethnic personal care items, gifts, kitchen and other housewares. Some of the stores also have other ways of connecting customers to their country[ies] of origin such as through the sale of international calling cards located usually near the entrance to the store. Four of the stores also had small restaurants that served ethnic foods. The meat stores (carnicerias in Spanish) offer grilling on weekends, where the customers can bring the meat they purchase outside and have it grilled for a tip to the employee. Many of the stores catered not only to one but to a multiplicity of ethnicities and also just added interest to those with ethnic food tastes.

6. Conclusion

While significant amount of attention has been paid to food deserts (a proximity-based food access approach), this study highlights that aspects addressing food store variety and diversity are also necessary for a comprehensive evaluation of food access. The study also suggests that caution should be given to the analysis scale (geographic units in this case) used to perform food desert or food access assessment as analysis results may vary substantially with scale. Due to the relatively coarse scale, the commonly used census tract based units may lead to an underestimate of the number of food deserts and the associated amount of people living in food deserts. While food assistance related policy decisions are often operationalized at the census tract scale, we suggest a sensitivity analysis be conducted to examine whether evaluations of food deserts or food access are robust at alternative scales.

This study also showed that independent stores add a great deal to the foodscape of Tucson. Going down to the tract level revealed that parts of some neighborhoods in Tucson could be considered to be food deserts. Independent food stores could assist these areas by granting them easier access to a wide variety of nutritious and affordable foods that would be socially acceptable to the ethnically diverse peoples that make up Tucson's population and to those with ethnic food tastes. Independent food stores are also an important part of a walkable downtown area and a city in which car travel in general is downplayed in favor of more environmentally friendly forms of transportation, including public transportation. They help lower income populations through their locations near housing but also because they accept government food assistance like food stamps and WIC and offer both small quantities and bulk items. In the far eastern and western areas of Tucson that are currently among those underserved by food stores and where residents must travel an average of four miles to purchase groceries, locating independent stores there would also be important to increase accessiblity. Independent food stores also offer a wide variety of services that make a city and its residents more socially cohesive, helping to add what urban planners such as Jan Gehl has famously termed 'life between buildings'. Independent stores do this by taking a more personal approach to customer service, by helping connect the customer to their countries of origin in a myriad ways, by selling goods that increase the array and diversity of products available,

and by offering services such as the grilling of meats on a hot summer day or the serving of cooked ethnic food in a restaurant connected to the store. Urban places are enriched by independent stores in multiple ways and help to convert what could otherwise be food deserts into a foodscape with affordable variety and choice.

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Appendix A

Comparisons of food prices in a supermarket chain (first list) with two independent stores.

Food items	Price	Regular price if on sale
Milk (regular) (1 gallon)	1.99	
Loaf of Fresh White Bread (1 lb.)	1	1.59
Rice (white) (1 lb.)	1.5	
Eggs (1 dozen)	3.5	
Local Cheese (Cheddar) (1 lb.)	5.99	
Chicken Breasts (Boneless, Skinless) (1 lb.)	2.89	
Apples (Gala) (1 lb.)	.99	
Oranges (1 lb.)	1.69	
Banana (1 lb.)	.49	
Tomato (Roma) (1 lb.)	.99	
Potato (Russet) (1 lb.)	.60	
Lettuce (1 head)	.99	

store.

Food items	Price	R if
Milk (regular) (1 gallon)	2.49	
Loaf of Fresh White Bread (1 lb.)		
Rice (white) (1 lb.)	1.20	
Eggs (1 dozen)		
Local Cheese (Cheddar) (1 lb.)	3.99	
Chicken Breasts (Boneless, Skinless) (1 lb.)	—	
Apples (Gala) (1 lb.)		
Oranges (1 lb.)	0.89	
Banana (1 lb.)	0.69	
Tomato (Roma) (1 lb.)	0.99	
Potato (Russet) (1 lb.)		
Lettuce (1 head)		

store.

Food items	Price	F i
Milk (regular) (1 gallon)	2.99	
Loaf of Fresh White Bread (1 lb.)	—	
Rice (white) (1 lb.)	1.09	
Eggs (1 dozen)	1.69	
Local Cheese (Cheddar) (1 lb.)	—	
Chicken Breasts (Boneless, Skinless) (1 lb.)	2.99	
Apples (Gala) (1 lb.)	—	
Oranges (1 lb.)	—	
Banana (1 lb.)	0.79	
Tomato (Roma) (1 lb.)	0.99	
Potato (Russet) (1 lb.)	—	
Lettuce (1 head)	0.99	